MBTA Sustainability Report

JUNE
2017

INTRODUCTION

Sustainability (sə¸stānə'bilədē) – *noun – the ability to be maintained at a certain rate or level; avoidance of the depletion of natural resources in order to maintain an ecological balance.*

The MBTA has always and will continue to play a major role in the sustainability plans for the Greater Boston Region – for our communities as a whole and for each individual for whom we provide safe, affordable and accessible transit service.

This Sustainability Report (the MBTA's second such report) is designed to inform our customers, our neighbors, our stakeholders, the taxpayers and our employees as to the major steps taken by the MBTA to fulfill its mission to create a more environmentally responsible, socially equitable and economically prosperous future for all of the Boston region and Massachusetts as a whole.

This report details some of the programs we have launched and the progress we have made toward reducing our own footprint and our environmental impacts. With a focus on energy and water saving, greenhouse gas reductions, increased recycling, improved materials management and reducing air emissions, the MBTA has taken steps to progress our own efficiency, in terms of both environmental impacts and costs. Through these programs, we have realized strong results. The MBTA plans on building on this success each year. In addition, with the ever increasing threat of extreme storms due to global climate change, the MBTA is increasing its focus on making our system more resilient so that it can continue to operate under these conditions and continue to supply the important service that is a significant component of our region's economic engine.

Just as our commitment to safety is a prime focus and the responsibility of all of our employees, environmental stewardship is now playing an increased role in the work that all of us at the MBTA do. Our goal is to make sustainability not just a program at the MBTA, but a core value that is at the heart of our mission and influences the way we do business. As reflected in our new Strategic Plan prepared under the direction of the MBTA's Fiscal and Management Control Board (F.M.C.B.), environmental stewardship is a principle upon which the organization has pursued a culture of continual improvement in management.

This report highlights some of the progress made to date and just a few of the programs and projects of which we are most proud.

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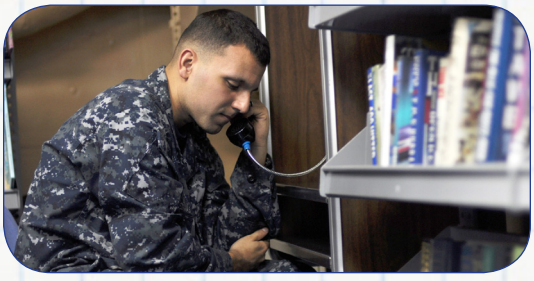
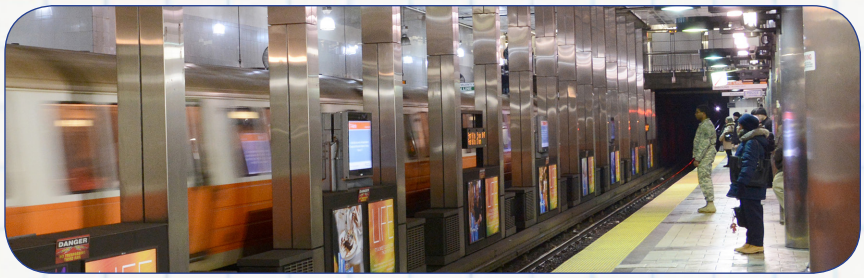
TRASH ONLY





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A MESSAGE FROM LEADERSHIP

massDOT
Massachusetts Department of Transportation

Secretary of Transportation
Stephanie Pollack

For decades, Americans have viewed transit as a critical component of our nation's environmental strategy. Transit is a safe and accessible alternative to the automobile, as well as a significant element of a sustainable land-use strategy that helps support strong and resilient cities.

But at the same time, the MBTA has a substantial environmental footprint. As the largest single consumer of electricity in the Commonwealth, and one of the largest consumers of diesel and natural gas in New England, the MBTA has a significant emission profile, particularly of greenhouse gases. I have long advocated that our transportation system should operate in the most environmentally sustainable fashion possible – in terms of both how we help our customers reduce their environmental footprint and the way we manage our own footprint.

I am proud of the work that the MBTA has done to date to reduce its emissions and its impact on our natural resources. But we can and we will do more.

Under the leadership of Governor Baker, Lieutenant Governor Polito, and the FMCB, the MBTA has refocused its efforts on our customers and specifically on core services. To do this, the MBTA has invested a sizeable portion of its capital funds in new vehicles – more funding for new vehicles that the MBTA has spent in many years. These vehicles will be not only state of the art and more reliable, but also more energy efficient – from new Red, Orange, and Green Line vehicles that consume less electricity to new electric hybrid buses that have a fuel economy that is 44% lower than traditional diesel buses.

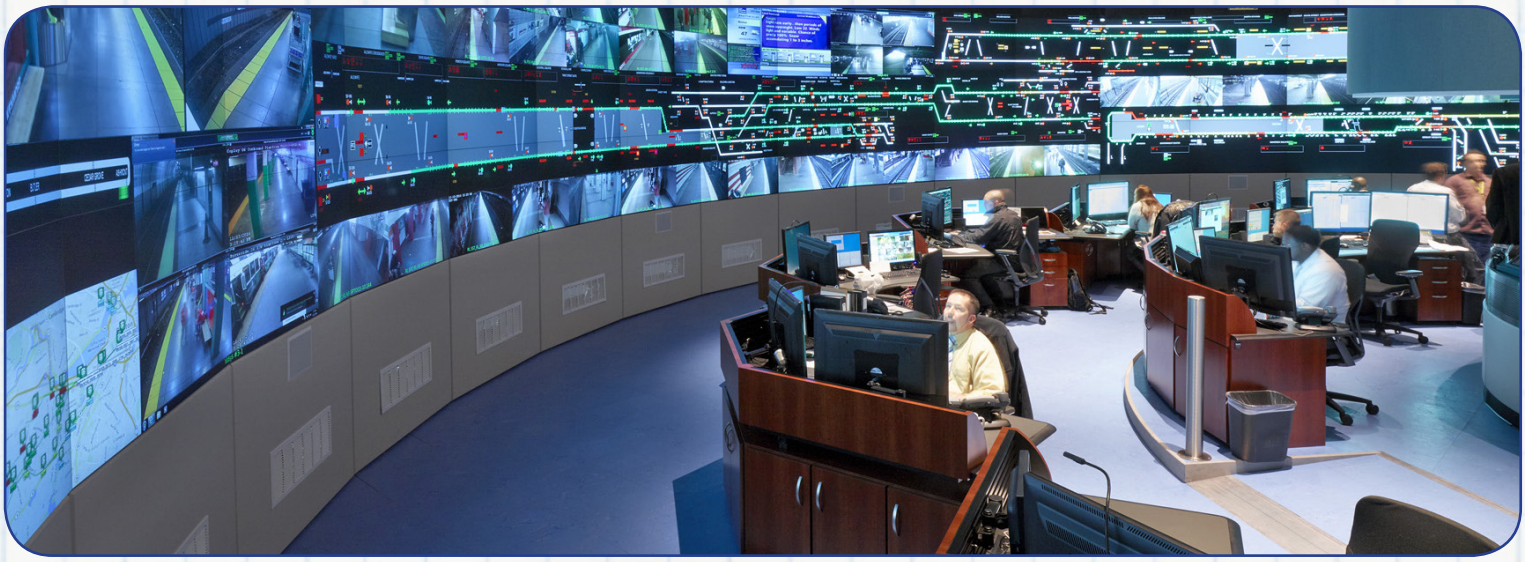
Our work on these critical issues will continue as we make our system more responsive to the needs of our customers and our taxpayers. We strive to use all of our resources as efficiently as possible, and this includes our natural resources. The MBTA, working with MassDOT and the FMCB, will continue to make the transit system as environmentally sustainable as possible as it strives to be a national leader for sustainable and resilient transportation.

A MESSAGE FROM LEADERSHIP

Chief Administrator & Acting General Manager
Brian Shortsleeve

Over the course of the past two years, fiscal sustainability and reliability has been the main focus for the MBTA. Under the direction of Governor Baker and Lt. Governor Polito as well as the FMCB and MassDOT, the MBTA has made strides to stabilize the operating budget, accelerate capital delivery, and improve the customer experience.

Our focus on fiscal sustainability has provided us with an excellent opportunity to bring greater attention to environmental sustainability. Energy – in the form of electricity, natural gas, diesel and gasoline, as well as water and other utilities – represents a significant component of our operating budget. The volatility of the costs of these commodities brings an increased risk to the budget. Reducing the consumption of and the cost of these utilities results in not only financial benefits but also reductions in greenhouse gases and the size of our environmental footprint. In the past two years, we have reduced utility costs by 27.7% and greenhouse gases by 16%.



In addition, we are eager to meet the challenges set forth by Governor Baker in his Climate Change Executive Order, which, among other things, calls on state agencies to reduce their carbon output and to prepare their systems to be more resilient to the effects of climate change. Our focus on environmental sustainability will become even more important as we work toward meeting the high standards and key goals established by the Baker-Polito Administration.

Addressing all of these challenges will not be simple, but the MBTA is well positioned to meet these goals. As we continue to make improvements to the MBTA, we will focus on expending fewer resources, consuming less energy and reducing waste, all of which help reduce our environmental footprint and ensure that the MBTA can continue to operate with sound fiscal and environmental practices well into the future.

A MESSAGE FROM LEADERSHIP

Chairman
Fiscal and Management
Control Board
Joseph Aiello

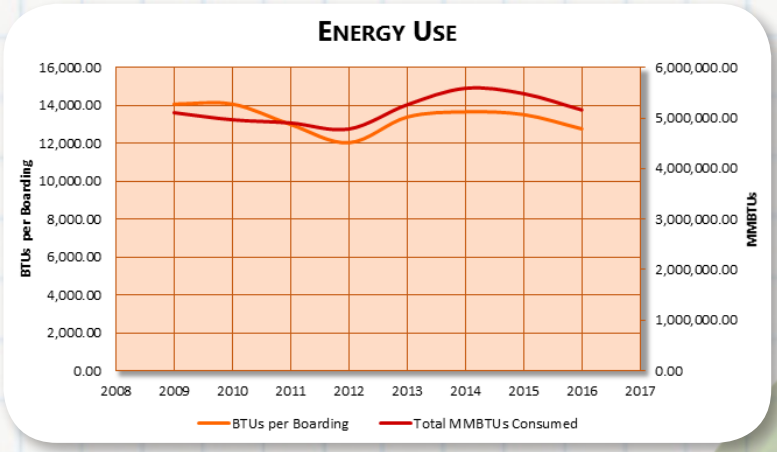
When Governor Baker and the Legislature created the Fiscal and Management Control Board in 2015, it did so to provide greater oversight of the finances, management and operations of the MBTA. We have focused our efforts on addressing systemic management challenges so as to restore public confidence in the MBTA and reestablish its place as a premier regional asset to support our economic growth. Massachusetts has long recognized that our region's environmental health is key to our economic health. The role that a strong, reliable and accessible transit system plays in that environmental and economic health cannot be understated.

The winter of 2015, which dumped more than 109 inches of snow on the region through four blizzards in less than three weeks, not only highlighted the frailties of the condition of the MBTA, but also highlighted the degree to which the transportation network could be stymied by extreme storm events, and how the economic vitality of the region can suffer as a result. Given the likelihood of more extreme storms it is critical that the MBTA be prepared for more extreme and more frequent storm events resulting from global climate change.

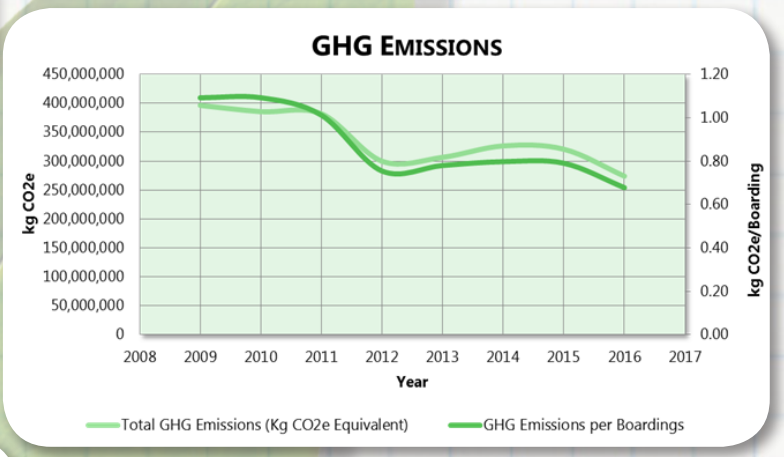
With this history in mind, the FMCB has made environmental sustainability a key focus of the organization. I am proud that our recent Strategic Plan, which is the FMCB's blueprint for our work to continually improve the MBTA, has identified Environmental Stewardship as one of our key values and our ability to respond to the challenges of climate change and to prioritize environmental stewardship as one of our ten guiding principles.

It is the FMCB's expectation that this Strategic Plan will drive all of the plans, programs and activities of the MBTA. By bringing an increased focus on environmental stewardship to the MBTA, we will work toward meeting our vision of making the MBTA a globally premier, safe, reliable, convenient, accessible, cost-effective and sustainable transit service to its communities and customers.

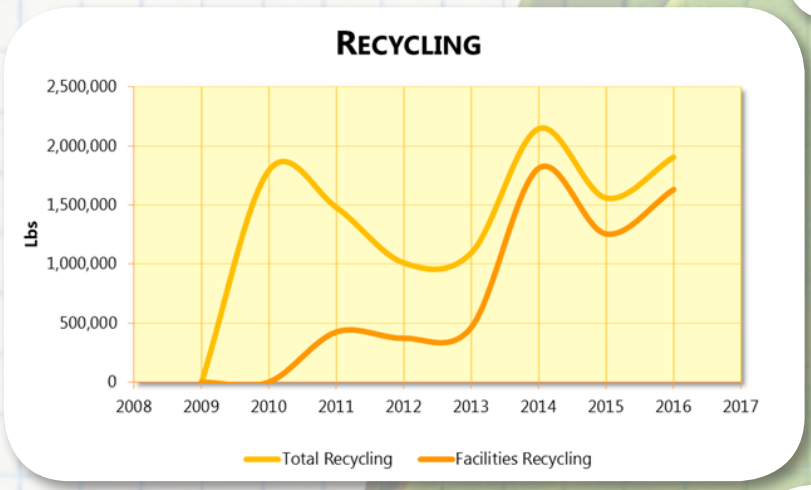
TRACKING OUR IMPROVEMENTS



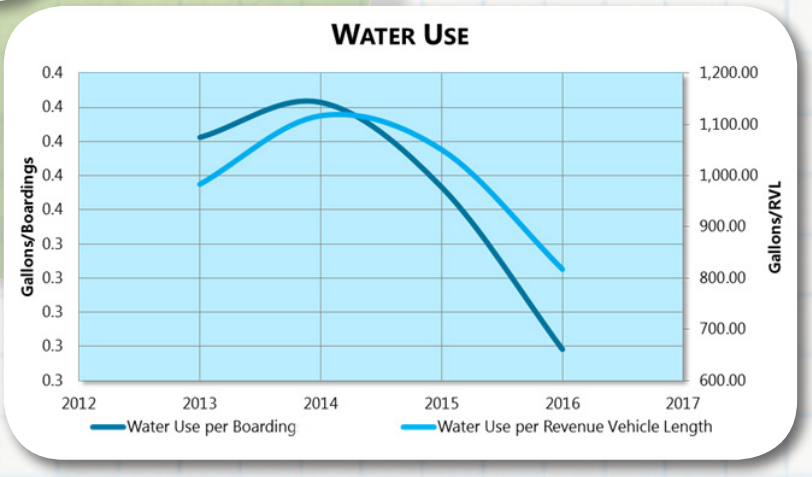
Energy Use: This graph shows the total energy used by the MBTA from 2009-16 in MMBTUs (one million British Thermal Units (BTU), as well as the energy use per passenger boarding. The MBTA consumes nine types of energy from electricity and diesel to jet fuel.



GHG Emissions: This graph shows the cumulative Greenhouse Gas emissions from the MBTA. These numbers are calculated from fuel consumption as well as electricity use. While energy use was higher in 2016 than in past years, GHG emissions were the lowest ever due to converting old equipment to more GHG-efficient fuel sources, such as the diesel-powered Commuter Rail locomotives.



Recycling: This graph shows the total tonnage of recycled material at the MBTA from MBTA facilities, stations, offices and right of ways.



Water: This graph shows the total water consumption at all MBTA facilities. The MBTA's ability to track and manage its water use has greatly improved in the past few years, leading to the lowest amount of water consumed since tracking began.

PROJECT:
Electric Vehicle Stations
BEGAN:
September 2012
DEPARTMENT:
Environmental & Parking

In an ongoing effort to promote the use of alternatively fueled vehicles, the MBTA received a grant from the Department of Energy Resources (DOER) to install 29 electric-vehicles charging stations at the garages of Alewife, Braintree, Route 128, Quincy Adams, Wonderland and Woodland stations. The MBTA then installed additional charging stations at Littleton, Beverly and Salem stations.

The program has been quite successful, and the usage reflects how much customers appreciate the stations. In 2016, the charging stations dispensed 420,132 kWh of electricity and prevented approximately 17,697 kilograms of greenhouse gas from being released into the atmosphere. There were approximately 4,488 charges at the stations for the year. The EV charging stations at Alewife were the most highly used in the system.

The MBTA, working with MassDOT, is now looking to install new EV charging stations throughout its parking network, providing a sustainable transportation option for our customers.

THE PROGRAM

- Installed 29 electric-vehicle charging stations at MBTA Park & Ride lots
- Gather data to better understand customer usage and environmental benefits

THE OBJECTIVE

- Create an opportunity for the use of alternatively fueled vehicles at MBTA stations
- Encourage cleaner and more sustainable transportation options and links to transit

WHAT'S NEXT?

- Install additional EV charging stations throughout the MBTA system
- Seek additional funding to expand the program with minimal impact on the MBTA budget

PROJECT:
Hydrogen Bus
BEGAN:
2016
DEPARTMENT:
Bus Operations, Engineering & Maintenance

Under the Federal Transit Administration's (FTA) National Fuel Cell Bus Program (NFCBP), the MBTA is hosting a pilot project of a 40-foot hydrogen-powered passenger bus. The pilot project is managed by the Northeast Advanced Vehicle Consortium (NAVC), and the vehicle was built by El Dorado, National, Ballard Power Systems and BAE Systems. The goals of the program are to improve transit-bus fuel technology, decrease petroleum consumption, reduce emissions from public transportation, and increase public acceptance of fuel cell technology. The MBTA hydrogen bus is one of 12 hydrogen buses in eight states funded through the FTA's NFCB program.

The hydrogen fueling station located in the MBTA's Charlestown bus yard was built, designed and installed by Nuvera Fuel Cells out of Billerica, MA. The onsite hydrogen fueling system extracts hydrogen atoms from natural gas and stores it as a compressed gas. The onboard mechanism, called a polymer exchange membrane fuel cell, pushes pressurized hydrogen gas through the catalyst, causing the hydrogen molecule to split. The two electrons are captured and used for electricity to power the bus, while the remaining positively charged hydrogen ions join with oxygen to form water molecules. Water vapor is the only discharge generated from the operation of the bus, which is why it is called a zero-emission vehicle.

The zero emission hydrogen bus is currently operating on Route 104 between Malden Center and Sullivan Square; Route 108 from Linden Square to Wellington Station; or Route 109 between Linden Square and Sullivan Station.

THE PROGRAM

- Launch the first MBTA hydrogen bus and fueling system
- Train drivers and maintenance personnel on driving the buses and procedures to safely handle the equipment

THE OBJECTIVE

- Operate the bus in MBTA service to see how it operates in day-to-day conditions
- Gather data on carbon emissions and other environmental factors

WHAT'S NEXT?

- Evaluate the emerging technology to determine what role it can play in the MBTA's future bus fleet
- Investigate future clean-energy ventures to enhance the daily operations of the Authority

PROJECT:
Efficiency/
Equipment Retrofit
BEGAN:
2010
DEPARTMENT:
Engineering &
Maintenance,
Environmental

Since 2010, the MBTA has been implementing energy-efficiency measures throughout the rapid transit system. The MBTA has collaborated with local utilities and state agencies to upgrade facilities, reduce energy use and improve safety at the lowest possible cost of ownership. To date, the MBTA has completed 81 projects. This results in a savings of 54.5 million kWh and $4.6M. This reduction in electricity consumption has also resulted in 17,383 tons of greenhouse gases avoided annually. Working closely with utilities and state agencies, the MBTA has utilities energy-efficiency incentives to avoid project costs of $2.3 million.

Dudley Square bus station is a great example of energy efficiency providing multiple benefits. Prior to implementation, the waiting areas and busways were lit by inefficient, orange-colored, high-pressure sodium bulbs. The MBTA installed energy-efficient lighting that not only improved the lighting levels, it also made the bus area look cleaner and, most importantly, made the MBTA customers and employees feel safer.

In another example, the MBTA faced a great challenge harnessing its track-switch and third-rail heating. Heat is required in winter months to mitigate ice buildup that would prevent trains from operating otherwise. By cutting the power of the heaters in half and implementing a control system that would reduce the "on" time by 66%, the MBTA expects to achieve an annual savings of 25 million kWh and a reduction in greenhouse gases of 7,974 tons annually .

HEATER SWITCH MELTING SNOW

A full inventory of the MBTA's energy-efficiency results can be found on the Energy Scorecard located on page 8.

THE PROGRAM

- 81 energy-efficiency retrofit projects completed throughout the MBTA system

THE OBJECTIVE

- Lower the MBTA's energy costs by reducing our need to consume electricity
- Reduce the MBTA's energy footprint and output of greenhouse gases

WHAT'S NEXT?

- Improve our energy performance by reducing our consumption by more than 25 million plus kWh over the next three fiscal years
- Utilize new and emerging technologies for energy reductions

ENERGY - CONSERVATION SCORECARD

massDOT
Massachusetts Department of Transportation

	2015	2016	Since Inception
Energy Savings (kWh)	2,917,995	10,032,810	15,303,794
Energy Savings to date*	4,187,646	1,331,210	56,159,852
Power Savings (kW)	836	192	2,980
Energy Cost Savings	$281,484	$652,133	$1,742,661
Cost Savings to date*	$356,400	$114,700	$4,777,468
Avoided Project Cost	$697,461	$2,686,287	$3,866,493
Average Payback Period	2.85	3.38	1.31
Pollutant Offsets (in LBS)			
CO2	2,415,960	8,306,685	12,670,807
CH4	225	773	1,178
NOx	44	152	233

Environmental Equivalents	2014	2015	Since Inception
Gallons of Gasoline	230,808	793,578	1,210,504
Households**	270	929	1,417

Project by Property Type	
Administrative	7
Maintenance	29
Parking Garage	8
Parking Lot	14
Station	14
Substation	10
Tunnel	2
Right of Way	4
Total	88

Notes:

** Since completion of each project*

***Households - average annual electrical usage of Massachusetts household*

PROJECT:
Operations Control Center Upgrade
BEGAN:
May 2015
DEPARTMENT:
Engineering & Maintenance

One of the most critical buildings of the MBTA is located at 45 High Street in downtown Boston. The 10-story building is home to a number of important departments and functions, including Operations Administration, Operations Control Center (subway & bus), IT hub and Red Line sub-station.

In 2015, the MBTA started to investigate how it could make 45 High Street more sustainable. The HVAC system was not performing properly and required immediate attention. In late 2015 and early 2016, one of two chillers was replaced along with the rooftop cooling tower. At the same time, a number of major pipes in the system were also replaced since they hindered the functionality of the system. Since their replacement, the system requires much less water and electricity to run.

On a parallel path, the MBTA started implementing an Energy Enterprise Management System that will enable building maintenance personnel to better monitor energy usage. In addition, the MBTA is working with local utilities to get a detailed audit of the entire facility with the primary goal of upgrading the HVAC control system and installing more efficient lighting and plumbing fixtures.

Since the building is critical, the MBTA is working to replace and upgrade the fire and safety equipment along with refurbishing the computer technology hub, which, in addition to maintaining the building's critical functions, will also use less energy and assure the safety of its employees.

THE PROGRAM

- Replace rooftop and tower cooling and chilling systems
- Implement Energy Enterprise Management System to monitor energy usage

THE OBJECTIVE

- Reduce the energy consumption of the Operational Control Center without affecting its critical functions
- Utilize new technology to better manage energy consumption

WHAT'S NEXT?

- Audit the building's HVAC, electrical and safety components to make improvements to the systems

PROJECT:
East Boston Climate Change Assessment
BEGAN:
2015
DEPARTMENT:
Environmental

By the end of this century, the Boston area is expected to experience sea-level rise of three to seven feet, not including the storm surge from Nor'easters and other coastal storms. The MBTA's Blue Line traverses areas in Downtown Boston, East Boston and Revere that are primarily below elevations of 15 feet. Multiple areas of the line, including the Aquarium Station, Orient Heights Station, and the tunnel Portal east of Maverick Station, are increasingly vulnerable to flooding.

The MBTA is working with the East Boston-based Neighborhood Organization of Affordable Housing's (NOAH) ClimateCARE program to identify climate change vulnerabilities in the community. Among the numerous environmental-justice challenges the community has faced are industrial contamination of its air and waterways. Climate change now presents another environmental-justice challenge for East Boston.

As a member of the ClimateCARE Adaptation Planning Working Group (APWG), the MBTA has conducted a climate change vulnerability assessment of the Blue Line, which serves as a key economic lifeline, connecting communities in East Boston and Revere to places of employment in Downtown Boston.

Moving ahead, the MBTA will continue to work with NOAH and other APWG members to enhance the resilience of the Blue Line and the entirety of East Boston, ensuring that residents remain connected to their community and places of employment. Additionally, the MBTA will expand its vulnerability assessment to include other rapid transit lines, commuter rail systems and maintenance facilities to identify other assets that are threatened by climate change.

THE PROGRAM

- Identify the MBTA assets and systems along the Blue Line that are most vulnerable to the effects of climate change
- Incorporate the MBTA vulnerability assessment with those of other agencies and stakeholders in the neighborhoods

THE OBJECTIVE

- Design specific solutions and operating procedures to help protect critical assets from flooding, sea-level rise and other climatic events
- Coordinate with local community leaders to better prepare for emergency conditions

WHAT'S NEXT?

- Continue to work with communities to ensure that their economic conditions and access to transit are not affected by increasingly extreme storms
- Prepare similar vulnerability assessments for other transit lines and modes

PROJECT:
Cell Phones for Soldiers
BEGAN:
January 2012
DEPARTMENT:
Authority Wide

Since April 2012, the MBTA has been working with the charity Cell Phones for Soldiers to collect old cell phones to provide free phone time for soldiers stationed overseas. The program was started in 2004 by Robbie and Brittany Bergquist (then ages 12, 14) from Norwell, MA.

Most cell phones contain precious metals that can be recycled to save energy and resources that would otherwise be required to be mined or manufactured to be replaced. When placed in a landfill, these materials can pollute the air and contaminate soil and drinking water.

In the first year, the MBTA, along with MassDOT, recycled more than 2500 cell phones and, in addition, more than 1800 chargers. In that year, the T worked with a local recycling company, since it was too expensive to ship the phones,and gave a check to Cell Phones for Soldiers (CPFS) in the amount of $2,268. Since that year, the Authority has worked directly with CPFS and has collected close to 6,000 phones, which have provided approximately 21,000 one-hour phone cards for soldiers overseas.

Through the years, the MBTA has collected phones at the Transportation Building, 45 High Street, North Station and Back Bay Station. Presently there are boxes at 10 Park Plaza and Back Bay station. The MBTA is committed to collecting old cellphones with the double advantage of keeping them out of the landfill and making soldiers' lives overseas better.

THE PROGRAM

- Provide MBTA/MassDOT employees and customers with an opportunity to help military personnel

THE OBJECTIVE

- Responsibly and sustainably dispose of nearly 6,000 cell phones that would otherwise end up in landfills
- Provide oversees military personnel with 67,000 minutes of free phone time

WHAT'S NEXT?

- Continue to collect more cell phones with a goal of 10,000 phones by 2018
- Expand the program to more customer locations throughout the MBTA system

PROJECT:
Sustainable Bus Cleaning
BEGAN:
Spring 2015
DEPARTMENT:
Bus Operations

In November 2015, the Cleaning and Maintenance Department in Bus and Rail Operations started to investigate ways to add an additional level of sanitized protection to vehicle interiors. They wanted to provide additional protection to customers during flu season, using the most environmentally safe products at the same time.

The MBTA turned to the Toxic Use Reduction Institute (TURI) at the University of Massachusetts Lowell for recommendations. TURI provides resources and tools to help make Massachusetts a safer and more sustainable place to live and work.

Since environmentally safe cleaning products have become much more available over the past five years, the MBTA's cleaning contractor could use a number of efficient cleaning products that are also environmentally safe. Not only do these products clean as effectively, but also in some cases, they work better and are easier to apply, and they do not expose employees to harmful toxins.

One technologically advanced system that the MBTA began testing creates a sanitizer that kills bacteria and viruses on contact by combining water with salt and applying a small electrical charge to the mixture. This method takes five minutes to sanitize a bus and kill any contaminant on any surface or vent with remarkable results.

The sanitation of the entire MBTA bus fleet of approximately 1,060 was completed by January 2016. Disinfecting in conjunction with the standard cleaning process assures a safer environment for the MBTA's customers, its employees and its contractors. The MBTA is committed to implementing the use of cleaning products and procedures that are environmentally responsible and are also effective. It continues to work with organizations like TURI to achieve the best possible results.

THE PROGRAM

- Use environmentally safe cleaning products that reduce the spread of germs

THE OBJECTIVE

- Establish cleaning procedures to clean vehicles sustainably so as to reduce customers' exposure to germs, particularly in cold and flu season
- Implement new cleaning procedures that reduce workers exposed to toxins

WHAT'S NEXT?

- Implement a program in which all buses are cleaned quarterly using new sustainable products
- Expand the program to include subway vehicles

MATERIALS MANAGEMENT

PROJECT:
Station Recycling
BEGAN:
September 2015
DEPARTMENT:
Engineering & Maintenance

At busy Alewife Station, seven-foot-tall kiosks built with 100% recycled materials offer MBTA customers the opportunity and information to recycle on the go.

The two kiosks are part of a recycling pilot program in partnership with MassRecycles, the Massachusetts Beverage Association and Casella Recycling, with the long-term goal of increasing recycling in MBTA subway stations.

"Increasing recycling is a top priority in Cambridge," said Cambridge Mayor David Maher. "I know that residents of Cambridge and surrounding areas are committed to protecting our local environment, and this program gives them added infrastructure to do what is right."

By expanding the program and adding more receptacles, the MBTA hopes to increase the amount of valuable materials added to recycling tonnages, including aluminum and PET (the material used for water bottles).

DID YOU KNOW?
Recycling ONE ALUMINUM CAN saves enough energy to listen to a full album on your music player.
Recycling with the MTBA protects our environment, supports over 14,000 local jobs and is cost effective. Do your part today!
MIXED RECYCLING
Please toss into the BLUE opening!
PAPER PRODUCTS • BOTTLES • CANS
TRASH ONLY
Please toss into the BLACK opening!
CUPS • PLASTIC BAGS • DIRTY ITEMS
TRASH ONLY
Sponsored by
Sustainability

"Highly traveled public spaces like MBTA subway stations are a critical part of the waste-reduction puzzle in Massachusetts," said Edward Hsieh, Executive Director of MassRecycle.

In December 2016, the project was expanded from Alewife Station along the Red Line to Kendall, thanks to a grant from the Cambridge Redevelopment Authority and matching funds from private companies. In addition, advertising signage was sold to cover extra operation costs, and Casella Waste Systems voluntarily picks up the singles-stream recycling.

THE PROGRAM

- Establish – for the first time – single-stream recycling in an MBTA Station
- Create a public/private venture that helps maintain the system

THE OBJECTIVE

- Provide MBTA customers with easy and understandable access to recycling of all products – not just newspapers
- Utilize a public/private partnership to improve station management

WHAT'S NEXT?

- Expand the program throughout the entire system with an emphasis on continued funding from outside sources such as was achieved on the Red Line
- Work with other stakeholders and municipalities to expand single-stream recycling in other lines and other modes

MATERIALS MANAGEMENT

PROJECT:
Facility Recycling
BEGAN:
2010
DEPARTMENT:
Environmental, Train Opertations

Since 2010, the MBTA developed an expansive and comprehensive recycling program at its bus and rail facilities. Our bus and rail maintenance facilities, however, generate large quantities of materials that by law cannot go into the trash. Many of these materials have a scrap value and generate revenue for the MBTA. The recyclable materials include air conditioners, batteries, cardboard, computers and related equipment, paper, plastic, metal and wood. Each of these materials must be processed for recycling separately.

In addition to recycling at the maintenance facilities, the MBTA has been recycling newspapers from the stations. In 2016, the Authority recycled 274,200 lbs. of newsprint. The MBTA is committed to increasing the recycling program at its stations (see "Station Recycling,"page 13) and to continue to make sure all recyclable materials are managed in a proper manner.

The following chart tracks our recycling progress. There are natural changes in the amount of recyclable materials since the volumes of materials coming into the MBTA fluctuate from month to month. Additionally, some materials are often stockpiled and recycled in one large batch to make the recycling effort as cost effective as possible.

Recycled Material in Lbs.	2012	2016	% Change
Batteries	4,545	400	-91%
Cardboard	71,607	136,000	89%
IT	37,872	17,012	-55%
Paper	13,237	1,484	-89%
Plastic	5,932	700	-88%
Wood	-	278,178	
Metal	211,419	1,200,210	467%
Sub-Total	**344,612**	**1,633,984**	**374%**

THE PROGRAM

- Minimize waste and increase recycling systemwide

THE OBJECTIVE

- Implement a program that efficiently and responsibly separates recyclable items from trash at maintenance facilities
- Increase recycling at MBTA maintenance facilities

WHAT'S NEXT?

- Continue to educate the workforce on how to recycle material more at the maintenance facilities
- Increase the level of recycling to offset cost of waste disposal

PROJECT:
Oil Filter Recycling
BEGAN:
September 2016
DEPARTMENT:
Opertations

The MBTA operates 15 facilities responsible for maintaining our fleet of buses, trains, work vehicles, passenger vehicles and associated heavy and light equipment. The facilities handle a number of different kinds of waste, from steel and wood pallets to oil from the engines of buses and trains. While the MBTA responsibly handles waste oil by repurposing it for further use, it must also deal with the waste of oil filters.

In an effort to comply with federal and state regulations, the MBTA has implemented oil filter crushers at many facilities. The filter crushers crush the oil filters to 20 percent of their original size, while removing up to 98 percent of residual oil and sludge. The crushed filters are recycled as scrap metal, thereby satisfying the Commonwealth's solid-waste disposal ban, while reducing our solid-waste volume and landfill impacts. In addition, the residual waste oil in the filter is captured and disposed of as a recyclable material in accordance with local and federal regulations.

The MBTA used more than 6,500 oil filters in 2016 alone – well over a metric ton of recycled steel!

THE PROGRAM

- Implement a system to safely and sustainably reduce oil-contaminated waste at facilities
- Provide employees with appropriate equipment to easily dispose of hazardous materials in the appropriate manner

THE OBJECTIVE

- Find cost-effective and implementable ways to remove hazardous waste from maintenance facilities
- Establish waste-management procedures that do not interfere with the important work at the garages

WHAT'S NEXT?

- Install oil-filter crushers at all maintenance facilities by the end of 2017
- Develop new ways to reduce waste and disposal costs at maintenance facilities

SUSTAINABLE DESIGN

PROJECT:
Government Center Station
BEGAN:
March 2014
DEPARTMENT:
Capital Delivery

On March 21, 2016, improvements to the Government Center Station were completed, and the station was officially open to the public, making it accessible to people with disabilities for the first time in its 118-year history.

There are a number of important sustainability-related aspects of the project with regard to energy, air, water and stormwater.

The entire electrical system for the station and headhouse utilizes modern efficient equipment such as LED lighting and a sophisticated on-demand multi-fan ventilation system that uses 60 percent less electricity than standard systems. There is sealed gas-filled lo-E glass, allowing for conservation of heat and diffusion of summer sun. Supplemental natural light filters through the structure via glass-block flooring, enabling light to reach the subterrain station floor. The station floor is terrazzo, a composite that contains recycled glass.

A number of sustainable elements are incorporated into the exterior environment. A minimum of 25 percent fly ash, slag concrete or silica fume is used for all structural concrete, and permeable pavers are incorporated into the walking areas. There is extensive urban landscaping with multiple trees, and water drainage from the roof is used to water the landscaping, thereby helping to improve stormwater quality. Exterior lighting and street lamps use LED bulbs. Bike parking and Hubway bikes are available. Before the construction began, there was a systematic removal of hazardous materials, such as lead, asbestos and PCBs, all of which were commonly used in structures of that era. The paint contains low levels of volatile organic compounds, which are solvents that are released into the air as paint dries. Any granite removed was reclaimed for future projects.

The beautiful structure combines a more customer friendly and sustainable environment.

THE PROGRAM

- Reconstruct Government Center Station to create an attractive and functional station that is accessible to all customers
- Include sustainable elements along with better functionality

THE OBJECTIVE

- Utilize environmentally preferred equipment and design for the station, headhouse and landscaping to address critical concerns such as energy and water consumption and other environmental impacts
- Make the headhouse as energy efficient as possible using new technologies

WHAT'S NEXT?

- Incorporate modern, efficient and environmentally friendly components in all future MBTA capital projects
- Develop design standards for all new construction that help reduce consumption of natural resources and reduce operating costs by being more efficient

SUSTAINABLE DESIGN

PROJECT:
Hingham Intermodal
BEGAN:
2014
DEPARTMENT:
Capital Delivery

In February 2017, the new, 8,400-square-foot Hingham Intermodal Center opened its doors to the public. The facility, which is titled the Herbert L. Foss Intermodal Terminal, is named for a Congressional Medal of Honor recipient from the Spanish American War. From the terminal, MBTA ferries run from Hingham to Downtown Boston and also serve ferries running to the Boston Harbor Island.

The center was designed to meet LEED Gold standards and includes a number of environmental elements addressing valuable resources such as water and energy. The green roof helps to control stormwater discharge and keeps the facility cooler in the summer. One of the more environmentally friendly aspects of the project is the heating and air conditioning system, which includes a geothermal heat exchange that will cool the building in the summer and heat it in the winter. A geothermal heat exchange takes advantage of the natural subterranean temperatures that exist beneath a structure, and therefore saves energy costs associated with heating and cooling the building.

All rest rooms have low-flow plumbing and the lighting uses energy-efficient lighting fixtures and lighting-control measures. The paints, adhesives and sealants are low-toxic materials since they do not contain any volatile organic compounds (VOCs). The landscaping selected requires no outdoor irrigation and will be planted in early spring. The building was designed to fit into the surrounding architecture, yet incorporate open spaces allowing for natural lighting and views of the harbor.

Regarding weather and climate resiliency, the MBTA is designing the new ferry gangways to remain ADA compliant through the project's intended lifespan, even with projected sea-level rise. Additionally, critical utility and communications infrastructure has been elevated above the current flood zone so they will not be exposed during a coastal storm event.

The Hingham Intermodal Terminal is one of the most advanced, sustainable-design facilities

undertaken by the MBTA and sets the standard for all types of new construction.

THE PROGRAM

- Reconstruct Hingham Intermodal into a modern multipurpose ferry terminal and office building
- Install the MBTA's first geothermal heating and cooling system

THE OBJECTIVE

- Design to fit with surrounding architecture and meet LEED Gold standards
- Utilize modern technology to save energy and money

WHAT'S NEXT?

- Construct stations and terminals using LEED goals and other standards to assure an environmentally superior facility
- Incorporate new and emerging technology in future construction projects

PROJECT:
Energy Enterprise Management System
BEGAN:
2015
DEPARTMENT:
Environmental

In 2016, the MBTA launched an Enterprise Energy Management System (EEMS). This sophisticated system is the first phase of a program that allows the Authority to better manage energy consumption from subway lines and maintenance facilities down to the circuit level over the entire system.

Initially, the EEMS will centralize utility consumption and spending, allowing staff to drill down and address anomalies where and when identified. The MBTA will also utilize the system to conduct cost/benefit analyses on energy projects, benchmark energy intensity of similar assets, assign environmental metrics to MBTA operations, and compare historical trends for improved budget accuracy.

The second phase of the program will be to identify sub-metering opportunities for MBTA maintenance facilities, transit stations and concessions. After successful implementation, these new meters feed information via the Internet to the enterprise application, allowing for near-real- time analysis of energy consumption. This level of detail will allow for peak demand management, department-level accountability for energy use, and preventive maintenance.
The EEMS is the cornerstone in the MBTA's holistic approach to energy management: to optimize, conserve and regenerate energy wherever possible, which eventually translates into saving money.

THE PROGRAM

- Implement and install a modern technology system that enables energy managers to easily monitor electrical usage
- Utilize real-time data to analyze energy consumption

THE OBJECTIVE

- Increased savings through conservation and retrofitting equipment
- Better understanding of energy usage, which enables one to pinpoint critical concerns and equipment failure

WHAT'S NEXT?

- Utilize data to spotlight ways that excessive energy or water consumption can be addressed and reduced
- Utilize incoming data to project energy-use trends, identify efficiency opportunities and proactively offset peak demand

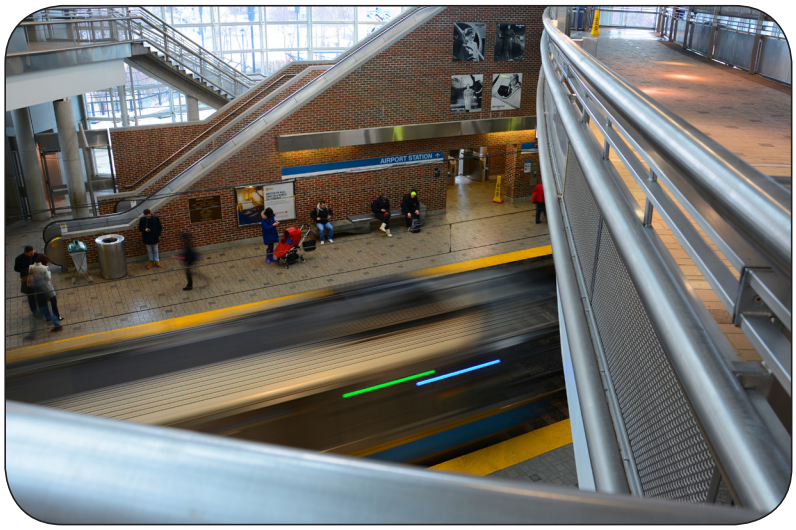
PROJECT: Regenerative Braking Pilot
BEGAN: 2016
DEPARTMENT: Subway Operations

Regenerative braking is the mechanism that recaptures the energy that is expended by trains braking as they enter a station or slowing down to go around a curve. Traditionally, the energy that is expended by braking is wasted as heat loss. Capturing this energy allows for energy savings, voltage stabilization and potential extension of equipment life, as well as a reduction in greenhouse gases.

In June 2014, the MBTA embarked on a pilot project to explore the benefits of regenerative braking. All subway lines were evaluated for the potential use of a wayside energy-storage system. Airport Station on the Blue Line was selected because the substation had the physical space to accommodate the technology and the vehicles were best suited to it.

With the system in operation by June 2015, the MBTA was able to claim savings of 250,000 kWh over the next year. In addition to more stabilized voltage, industry standards indicate a longer life cycle of the equipment because there is less stress on the train brakes. MBTA mechanical engineers are seeing an overall improvement in equipment life and will be able to quantify those benefits in the coming years.

Additionally, the new Orange and Red Line vehicles that start to come into service in 2018 will provide more opportunities to implement other regenerative braking locations across those lines.



THE PROGRAM

- Implement a new technology pilot program to capture and utilize the kinetic energy of braking trains
- Harness power from braking trains to save energy, stabilize the flow of electricity, and extend equipment life

THE OBJECTIVE

- Offset the Blue Line's power demand and reduce the energy consumption of trains passing through Airport Station
- Increase the life of the Blue Line trains' brakes and propulsion equipment while reducing overall maintenance needs

WHAT'S NEXT?

- Conduct feasibility assessments to determine where new technology could also be deployed for the same benefits
- Explore new opportunities in regenerative braking and energy capture such as battery storage or flywheel applications

PROJECT:
Cleaner Buses
BEGAN:
2014
DEPARTMENT:
Vehicle Engineering

The MBTA first started putting hybrid buses in service in 2010 with 25 60-foot articulated hybrid buses. These buses are used on the Silver Line because they travel in an underground tunnel and must use catenary connections to generate power through the tunnels.

In the fourth quarter of 2014, the MBTA started to replace conventional 40-foot diesel buses with New Flyer hybrid diesel buses. The initial order was for sixty (60) hybrid buses, and since then, Bus Operations has ordered an additional 150 buses of which 35 are now in service. A total order of 210 is expected to be in service by the end of 2017.

After extensive tracking, Bus Operations has data showing that the new hybrid diesel buses use 44 percent less fuel. Once the full fleet off 210 new hybrid diesel buses is in service, it can potentially save 830,000 gallons of diesel fuel annually, which means there would save 3.7 million pounds of greenhouse gas from being released into the atmosphere.

These buses do have a higher initial cost and require that the batteries be replaced around the six-year mark or during midlife overhaul. Yet the environmental impact, along with fuel savings, makes this additional expenditure worthwhile in the long run. The latest purchase from New Flyer has an option clause for an additional 200 hybrid buses.

THE PROGRAM

- Purchase fuel-efficient hybrid buses and integrate them into the fleet
- Deploy increasingly efficient and reliable vehicles for operational integration

THE OBJECTIVE

- Develop a modern bus fleet that reduces fuel consumption and runs more efficiently
- Consider overall burden and benefits of a hybrid bus program for the T, including lifetime operations and maintenance requirements

WHAT'S NEXT?

- Continue to purchase hybrid buses well into the future
- Align hybrid bus service schedule with the conventional bus schedule to ensure the seamless integration and operation of fleets

PROJECT:
Red, Orange & Green Line Trains
BEGAN:
September 2016
DEPARTMENT:
Vehicle Engineering

Facing a rapidly aging revenue vehicle fleet, the MBTA is procuring new cars for the Orange and Red Line subways, as well as deploying a mid-life overhaul program for a portion of existing Green Line cars. The procurement and overhaul projects both employ elements of sustainability.

The new Red Line and Orange Line cars will provide the MBTA with energy-saving features that include greater opportunities for regenerative braking, onboard LED lighting and reliable, efficient HVAC systems. By implanting the latest technologies in drive-trains, motors, and lighting and utilizing durable materials for the car body, these vehicles will run more efficiently and reliably than existing cars. The first Orange Line cars will enter service in January 2019 and the first Red Line cars in December 2019.

The Green Line overhaul project seeks to restore the vehicles' classic appearance, preserve the line's structural integrity, improve service reliability and reduce the vehicles' energy use. Major upgrades for the Green Line vehicles include a new type of HVAC system that uses a refrigerant dthat emits fewer greenhouse gases than older refrigerants do and improved vehicle energy efficiency via

a redesigned traction power supply and onboard LED lighting. The first overhauled car reentered revenue service in May 2015 after an extensive qualification process.

Additionally, the MBTA is committed to sustainable disposal of the existing fleet. Hazardous materials, such as mercury-containing thermostats, will be handled responsibly, and the vehicles will be scrapped so that the steel and other components can be reused or up-cycled into other products, as opposed to heading for a landfill or incinerator.

THE PROGRAM

- Continue to replace old and inefficient Orange and Red Line train cars with state-of-the-art new ones by 2023
- Deploy new cars that have advanced propulsion and braking systems for a better and more reliable trip

THE OBJECTIVE

- Save energy by utilizing better technology
- Operate more trains on the Red and Orange Lines to increase capacity by 50% during rush hours

WHAT'S NEXT?

- Continue to purchase rolling stock that utilizes the latest technology to reduce energy consumption
- Continue to expand the capacity of the fleet to allow more passengers to use the system, resulting in less GHG emissions

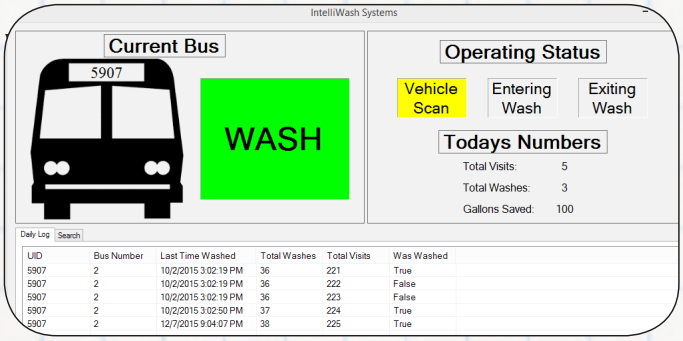
PROJECT:
Bus Wash Pilot Project
BEGAN:
May 2015
DEPARTMENT:
Engineering & Maintenance

The MBTA is always looking to find ways of implementing sustainable programs while reducing our operating costs without impacting our customers. The MBTA is currently piloting a water-conservation system that monitors the current bus-washing procedures. Due to physical constraints in the bus-maintenance facilities, buses are washed after passing through the fueling system. Since

a bus is fueled every day, it then enters the wash system every day, which is often unnecessary. Engineering & Maintenance worked with students from Wentworth Institute to develop a system that uses Radio Frequency Identification (RFID) tags on the buses to determine whether a bus has been washed within a certain number of days. If so, the system turns the wash off so the bus is able to go through the bus wash without consuming any water.

At the MBTA's Bus Maintenance Facility in Lynn, Engineering & Maintenance staff installed a pilot system for the 75 buses at the facility. The buses fuel twice a day, 365 days a year, which is equal to 54,750 washes a year. With an average consumption of 20 gallons/wash cycle, if buses were only washed once a day, the MBTA would save 547,500 gallons of water a year and save $7,555 on water and sewer charges. That is 1,095,000 gallons of water annually at a cost of approximately $24,865.

Once this system has been tested at the Lynn facility, it will be implemented at all bus-maintenance facilities. There are 11 bus garages and 13 bus-wash systems at the MBTA. With a fleet of approximately 915 buses in service on average, this new procedure could save over 6.6 million gallons of water and approximately $154,000 every


IntelliWash Systems
Current Bus
5907
WASH
Operating Status
Vehicle Scan
Entering Wash
Exiting Wash
Todays Numbers
Total Visits: 5
Total Washes: 3
Gallons Saved: 100
Daily Log
Search
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5907 2 10/2/2015 3:02:19 PM 36 221 True
5907 2 10/2/2015 3:02:19 PM 36 222 False
5907 2 10/2/2015 3:02:19 PM 36 223 False
5907 2 10/2/2015 3:02:50 PM 37 224 True
5907 2 12/7/2015 9:04:07 PM 38 225 True

THE PROGRAM

- Develop a system that ` monitors buses entering the fuel/wash alley at maintenance facilities
- Track each bus and monitor the amount of bus washes per 24-hour cycle at the pilot facility

THE OBJECTIVE

- Implement a technology solution that would allow the MBTA to reduce bus-wash water-consumption
- Utilize technology that can accurately track water-consumption data

WHAT'S NEXT?

- Expand the project to all bus-maintenance facilities
- Integrate other applications such as fuel used, time to refill tanks and miles traveled on shift

PROJECT:
Stormwater Management
BEGAN:
2012
DEPARTMENT:
Capital Delivery

In 2016, the Boston Metropolitan area experienced a severe drought, another indication of how precious our natural resources have become- specifically, water. The MBTA is fully aware of trying to conserve its water use. One of the more important ways is through the design of new buildings incorporating stormwater management.

Three of the latest construction projects completed incorporate stormwater management. Hingham Intermodal Terminal and Orient Heights Station on the Blue line both have green roofs. The American Society of Architects reports that, with most green roofs, nearly 78% of all precipitation is prevented from entering the sewer and water systems. There is also an ancillary effect since a green roof is much cooler than a conventional roof and therefore saves electricity by using less air conditioning in the summer heat.

At Government Center Station, the structure captures rainwater from the roof to help water the landscaping around the building, a practice that is also in place at Hingham Intermodal and Orient Heights. All three buildings also include permeable pavers that allow water to penetrate into the surface rather than creating unwanted runoff into sewer and drainage systems.

The MBTA is always looking for ways to mitigate future droughts, and green roofs and other stormwater-management solutions are a good way to do so. These systems help to recharge groundwater naturally and to reduce pollutants entering the environment.

THE PROGRAM

- Build modern, efficient stations and terminals that allow for water conservation and energy management
- Incorporate sustainable landscaping into efficent and attractive buildings

THE OBJECTIVE

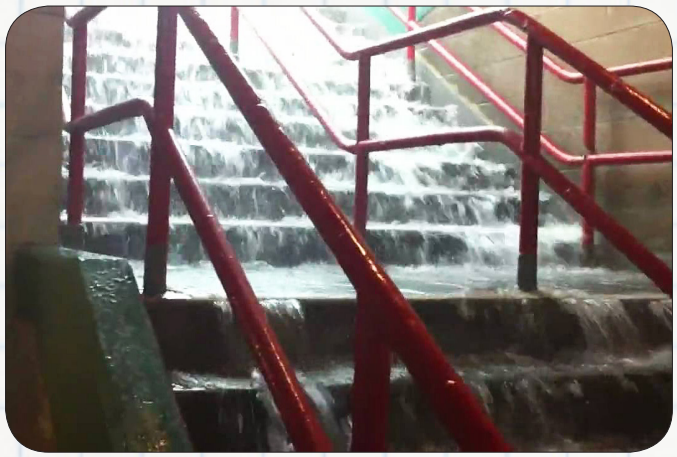
- Manage stormwater runoff and utilize the water for landscaping at new stations and terminals
- Install a green roof with native landscaping that will require little watering or annual maintnance

WHAT'S NEXT?

- Continue to build sustainable buildings that can save valuable resources and energy
- Explore new types of horticulture that can be used to minimize water consumption and improve stormwater quality

PROJECT:
Fenway Portal
BEGAN:
2016 (Design)
DEPARTMENT:
Capital Delivery, Engineering & Maintenance

Since its inception, the Green Line Tunnel D Line has been susceptible to precipitation-driven flooding, particularly at the portal near Fenway Station. Historically, the MBTA has responded to such events by utilizing sandbags and timber logs to prevent water from entering the portal. Most of the time, this approach has been effective and has prevented significant flooding from entering the portal. In October 1996, however, following two days of intense rainfall, the portal was breached with flooding that originated from the nearby Muddy River. This significant breach allowed water to travel through the tunnel, ultimately flooding Kenmore Station with water that continued up the center subway system all the way to Arlington Station. The flooding cut Green Line service to the area for over a week and caused $70 million in damage.



Forty-eight-hour precipitation events are projected to increase in intensity over the coming decades as a result of global climate change. Without intervention, the frequency and severity of flooding at the portal may also increase. With a $21 million climate-resiliency grant from the Federal Transit Administration (FTA), the MBTA is designing and installing a new comprehensive flood protection system at the portal. To protect the area during the lengthy set-up time, as well as for smaller events that will not require full deployment of the portal door, a supplementary system will be installed – increasing the existing concrete wall height around the portal by three feet and adding a barrier-gate system at the top of the incline that leads to the portal. These measures will make this area of the Green Line more climate resilient for decades to come.

THE PROGRAM

- Install a new comprehensive flood-protection system at the Fenway portal
- Install thermal-imaging cameras along the right-of-way and at the Muddy River, as well as an electronic river-height gauge

THE OBJECTIVE

- Protect the Green Line portal from flooding during extreme storms
- Provide the MBTA's Operations Control Center (OCC) with real-time information of potential flood risk through the use of cameras and flood gauges

WHAT'S NEXT?

- Assess and evaluate the vulnerabilities from the effects of climate change on the MBTA's assets
- Develop a prioritization of additional flood-control projects to be implemented over time

CLIMATE RESILIENCY

PROJECT:
Charlestown Seawall
BEGAN:
2015
DEPARTMENT:
Capital Delivery

The MBTA's Charlestown Bus Facility is the MBTA's largest bus-maintenance facility, housing and maintaining more than 230 buses, which serve close to 100,000 passengers each day. Located along the Mystic River, the site has experienced repeated flooding and erosion of its surrounding shoreline during high-water events. The seawall is in a deteriorated condition due to the tidal activity of the Mystic River. This loss of land has encroached on the facility's bus-circulation lane, even closing it recently due to safety concerns. The MBTA was concerned that increasingly extreme storms, due to climate change, would seriously jeopardize the facility and threaten our ability to continue to provide service. To stabilize the seawall and minimize the facility's environmental impact and increase the overall resiliency of the facility, the MBTA has secured Federal Transit Administration (FTA) funding to install a new wall, embankment and "riprap revetment" protection – a sloping shoreline structure to protect from scour and erosion. The MBTA will also implement major improvements to stormwater management in order to minimize runoff.

The southern portion of the new embankment will be vegetated with native plants for protection from flooding while also helping to filter runoff before it enters the river. The northern portion of the shoreline will be additionally protected by riprap. Atop the entirety of the embankment will be a wall to protect the facility from a 100-year storm event. Additionally, to contribute to a more community-friendly waterfront, the MBTA is working with the Massachusetts Department of Conservation and Recreation to develop a multi-use pathway on the river side of the wall.

When the project is completed, the facility will be much more resilient in the face of extreme storms and will also provide new recreational opportunities along the river for the neighborhoods.

THE PROGRAM

- Rebuild a dilapidated retaining wall, beyond its useful lifespan, with modern drainage and additional utility specifications

THE OBJECTIVE

- Prevent erosion at the MBTA's largest bus-maintenance facility and ensure that the site remains stable and completely functional, while also protecting habitat and water quality along the Mystic River

WHAT'S NEXT?

- Ensure that MBTA assets are climate ready and incorporate climate-changeresiliency standards into all MBTA capital projects

CHAMPIONS OF SUSTAINABILITY

VINCE CAMERON
Riverside
Train Facilty

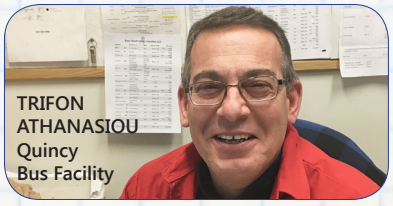
TECHNICAL PROJECT MANAGER, GREEN LINE
- Managed refurbishing cars that increases the life cycle of a train by 7 to 10 years
- To date, 48 cars have been refurbished and commissioned
- Continues to manage the project from the Riverside facility

ELLEN DENOOYER
Capital Delivery

SENIOR PROJECT MANAGER
- Led the design and construction of the Higham Intermodal facility
- Facilitated the process to meet LEED Gold specifications
- Constructed the MBTA's first geothermal heating/cooling system

ROCCO MINASI
Everett Shops

FOREPERSON, THE WOOD SHOP AT EVERETT
- Recycled all sawdust in the shop
- Ensured that wood was removed and recycled appropriately
- Minimizes waste by using efficient designs



TRIFON ATHANASIOU
Quincy Bus Facility

FOREPERSON, QUINCY BUS MAINTENANCE FACILITY
- Oversees the bus-maintenance program to ensure the fleet meets environmental, customer, operations and safety standards
- Responsible for diesel-fuel reconciliation for the facility
- Manages the single-stream recycling program

CANDICE TAYLOR
Capital Delivery

RESIDENT ENGINEER
- Coordinates all construction of systemwide underground storage tank replacement program
- Ensure scope of work is performed in accordance with contractual plans and environmental specifications
- Liaison to all stakeholders for these projects

JUNIOR MOLINA
Cabot Rail Facility

FOREPERSON, CAR-CLEANER, CABOT RAIL-MAINTENANCE FACILITY
- Manages the car house to ensure it is in compliance with the MBTA's environmental management system
- Supervises the recycling program at the car house
- Manages hazardous and non-hazardous waste in accordance with local, state and federal regulations

MAUREEN ROMANO
Lynn Bus Facility

CAR CLEANER, LYNN BUS-MAINTENANCE FACILITY
- Worked with Engineering & Maintenance on bus-washing project
- Manages the recycling program at the Lynn facility
- Assists in the environmental compliance program at the facility

DAVE KWAPIS
Charlestown Bus Facility

INSTRUCTOR, BUS-MAINTENANCE AND INNOVATION
- Participated in the development of a hybrid electronically controlled engine-cooling system that increases fuel mileage on average from 8 to 10 percent
- Trains mechanics on how to install and maintain the hybrid cooling systems
- Trains personnel on operating MBTA bus-emissions monitoring and control

ROB SAMPSON
Sytem-Wide Accessability Department

MANAGER, FIXED-ROUTE SERVICES
- Managed the transition of the first department to centralize waste disposal
- Investigated the previous process and encouraged fellow employees on the new plan
- Removed waste receptacles, leaving just two large receptacles in the central area to encourage recycling

Acknowledgements

This 2017 Sustainability Report was prepared by the MBTA's Environmental Department and specifically by Tim Lasker, the MBTA's Sustainability Specialist. Tim was assisted by other members of the Department, including Dan Abrahamson, Lois Baxter, Tom Daly, Cosette DeCoste, Michael Donaghy, Christine Lentini and Marybeth Riley-Gilbert. Data and performance metrics are based on the work by Sean Donaghy, who tracks sustainability metrics for the MBTA. The MBTA Marketing and Communications Department supported this effort through the development of graphics and photographs, most specifically Susana Hey.

Sustainability Report Acronyms

UPT – Unlinked Passenger Trip: a normalization factor that represents the number of unique trips taken on a single transit mode (i.e., Green Line, Red Line, Orange Line, 1 Bus, etc.) within the MBTA system, regardless of the number of stops traveled (e.g., taking the Green Line two stops and switching to the Blue Line for three stops equals two UPTs).

VMT – Vehicle Miles Traveled: a normalization factor that represents the number of vehicle miles traveled for whichever transit mode is currently being discussed.

MMBTU – One million British Thermal Units (BTU). A BTU is a standard unit of energy, equal to about 1,055 joules.

kg – Kilogram: the base unit of mass in the International System of Units, equal to 1,000 grams.

kW – Kilowatt: a standard unit of power or rate of energy consumption, equal to a 1,000W or a 1,000 J/s. Similarly, one MW or megawatt is 1,000kW.

kWh – Kilowatt-hour: a standard unit of energy, representing the number of kilowatts consumed per hour. Similarly, one mWh or megawatt-hour is 1,000kWh.

PSA – Per Capita in Service Area of Operation: a normalization factor representing the number of residents living in the geographical area served by the MBTA.

GHG – Greenhouse Gas: a term used to broadly represent all greenhouse gases as a collective; they are CO2 (carbon dioxide), CH4 (methane) and N_2O (nitrous oxide).

PPA – Power Purchase Agreement: a contract to purchase energy from an independent third party who installs alternative energy-generating systems on the purchaser's property.